(NASA-CR-175622) A NORMAL INCIDENCE, HIGH RESOLUTION X-RAY TELESCOPE FOR SOLAR CORONAL OBSERVATIONS Semiannual Progress Report, 1 Nov. 1984 - 30 Apr. 1985 (Smithsonian Astrophysical Observatory) 56 p
N85-23461
Unclas
G3/89 14714

A NORMAL INCIDENCE, HIGH RESOLUTION X-RAY TELESCOPE FOR SOLAR CORONAL OBSERVATIONS

Grant NAGW-397

Semiannual Progress Report No. 5

For the period 1 November 1984 through 30 April 1985

Principal Investigator:

Dr. Leon Golub

April 1985

Prepared for

National Aeronautics and Space Administration

Washington, DC 20546

Smithsonian Institution
Astrophysical Observatory
Cambridge, MA 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

The NASA Technical Officer for this grant is Dr. J. David Bohlin, Code EZ-7
NASA Headquarters, Washington, DC 20546

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NIXT PROGRESS REPORT

Table of Contents

0. Summary

Progress Report - NAGW-397 (NIXT)

0. Summary

During the six months ending 30 April 1985 we completed and/or advanced the following major activities:

1. Complete design of the entire telescope assembly and fabrication of all front-end components. The latter include secondary mirror mount and attachment structures, prefilter mount and attachment, MASS and LISS (sun sensor) attachments and Hα camera design;

2. Specification of all rocket skin sections, including bulkheads, feedthroughs and access door; drawings have been delivered to Wallops and fabrication is underway;

3. Fabrication, curing and delivery of the large graphite-epoxy telescope tube has been completed. Fabrication of an Invar ring which will attach the G/E tube to the primary support mount is underway and a precision fixture for accomplishing the attachment within the required alignment tolerances has been built;

4. An engineering analysis of the primary mirror vibration test was completed and a decision made to redesign the mirror attachment system to a kinematic three-point mount. Analysis showed that mirror fracture was due to a failure in the vibration facility rather than in the attachment procedure; however, the three-point mount causes significantly less figure distortion, permits removal of the primary mirror for multilayer coating

and has been previously used in rocket and balloon flights. All hardware for this modification has now been fabricated;

5. Detail design of the camera control, payload and housekeeping electronics has been completed, and fabrication of the boards is now beginning. Telemetry and interface agreements have been concluded with Lockheed, and acquisition of the necessary telemetry and pointing sections is underway;

6. Multilayer mirror flats with 2d spacings of 50 Å and 60Å have been produced and will be tested at Brookhaven NSLS this Spring. Some of the mirrors were annealed during deposition and are found to be stable against any further high temperature annealing; such mirrors should be stable in a satellite instrument for at least a few years. We also plan to test some sputtered multilayers made by ECD; these show very good performance at 1.54Å (at grazing incidence) but are not stable to 200 °C annealing.

7. An invited talk at the COSPAR Meeting in Graz, Austria in July, 1984 was written and appears in Advances in Space Research, 4, 75-82 (1984).

1. PDR At Wallops Flight Facility

IBM Milestone Interface Plan

SMITHSONIAN ASTROPHYSICAL OBSERVATORY

M E M O R A N D U M

To: Distribution

From: G. Nystrom GN.

Subject: Preliminary Design Review (PDR) on 27.099US-Golub/SAO

Date: 1 February 1985

The subject meeting was held on January 23, 1985 in the third floor conference room in building E108 at the Wallops Flight Facility. The following is a listing of actions, agreements and general minutes of the meeting:

Minutes:

Dr. Golub reviewed the concept of multi-layer coatings to reflect X-rays which allow the use of conventional normal incidence optics. Also, the planned investigations and typical exposure sequence were outlined. Concluding, he showed how this experiment may be reconfigured for follow-on rocket flights and its application to other space opportunities and vehicles.

George Nystrom presented the opto-mechanical design of the entire experiment section. A handout was presented to the attendees listing interface requirements, project milestones and science data. Drawings for the three rocket skin sections, which house the telescope, were given to R. Burns (WFF1022.9). Also, included was an assembly drawing of the vacuum access door.

Lockheed - Sparcs. H. Zimmer and T. Laughlin described the pointing and telemetry system approach. This is all standard equipment flown on numerous missions, discussion on antenna null patterns, drop outs, range configuration followed. These discussions were more for WFF personnels' familiarity with the range and were not a problem area. T. Laughlin designated Dr. Kohl's T-M package to be reconfigured to meet our needs.

WFF - Robert Buchanan, Code 841.1, presented an Aeroballistic Analysis for Golub 27.099US. The analysis was based on the material given by SAO in the P.I.C. and did not include the configuration changes discussed at the P.I.C., i.e. 6" extension section for weights. His analysis concluded that the six inch weight section was not required.

Discussion followed and a conclusion was reached that the aft weight skin section is a good idea and should remain. It should have a heavy ring section to allow weight attachment via screws.

At this junction, the PDR adjourned for lunch and reconvened in separate work groups to deal with interface specifics.

Action Items:

Organization	Responsible Individual	Action	Status
SAO	G. Nystrom	Provide copy of Mass Moment and Products of Inertia program to Bill Wallace.	Complete
SAO	G. Nystrom	Write John Shigemoto and include copy of Liss Sensor reconfiguration drawing.	Complete
SAO	G. Nystrom	Send remaining Rocket Skin Drawing to R. Burn WFF Code 1022.4	

Organization	Responsible Individual	Action	Status
Lockheed	T. Laughlin	A mapping of the pin relationship between J15 on the ITS console, and J203 on the T-M Interface. This is the Blockhouse to the NIXT experiment Interface through the umbilical cord.	
		Provide clean copies of the pin assignments for J201, J202, J203, J204, J205 on the T-M Interface.	
		TV camera power will be on J203, with 28V on pins j & k, and the return on pins s & t. Lockheed will command TV on.	
Lockheed	H. Zimmer	Provide SAO 10 foot lengths of cable for Liss and Mass sensors.	Complete
		Provide SAO with a schedule of events and requirements for White Sands checkout.	Complete
WFF	Ralph Welsh	Provide design and detail drawings of existing pull-away vacuum connection with motorized door.	
WFF	F. Lau	Provide information as to whether there exists a rocket qualified vacuum gauge for ATMOS to 1 x 10^{-3}mm to 1 x 10^{-5} TORR pressure range.	
WFF	UNK	Provide booster cable and connectors for passing thru experiment section. SAO to provide required length.	
WFF	UNK	Provide hermetic and T-M interface connectors.	
WFF	B. Burns	Provide Vacuum Door in Section 2.	
SAO	F. Licata	SAO to specified pin needs.	Complete

Agreements Reached:

1. Battery voltage will have a range of 24 to 32 with the camera voltage tap to be 5 to 7 volts.

2. The T-M format will be as shown on Figure 1. The rate will be 200 kbit.

3. Fred Lemon will cut to length the TV video line and insert the mating connector that will go to the 8 Mhz transmitter.

4. SAO will use the present White Sands GSE as is during the flight. SAO will only use its own GSE during checkout, through the umbilical connector.

5. Experiment will be composed of five skin sections.

6. SAO will build a H_α Camera system, however it will be commanded (on-off) and telemetered as the existing Lockheed H_α camera is.

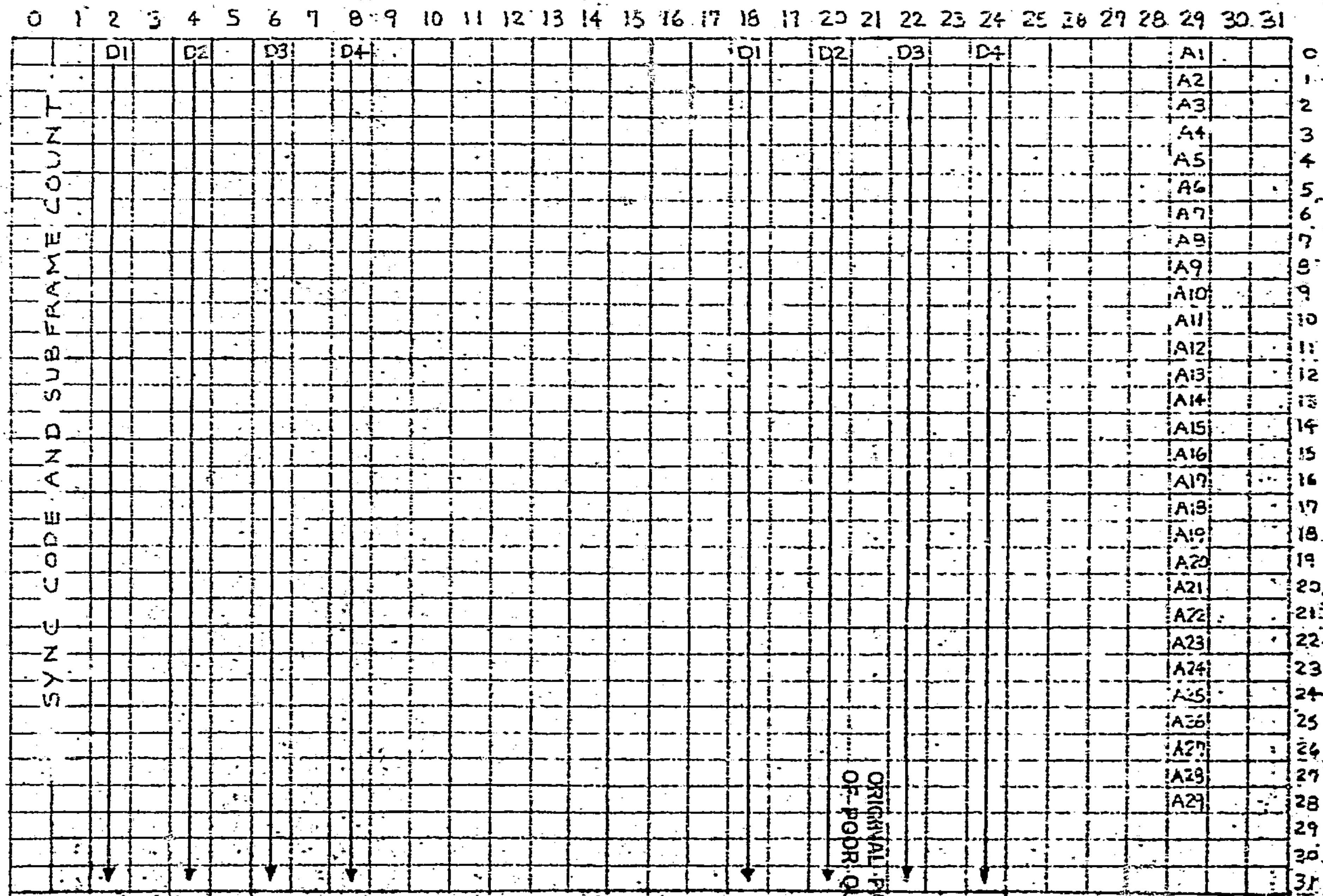
7. Twenty lines will be available to SAO on the main umbilical connector.

8. WFF will write to Dr. Kohl for return of Rocket Vacuum Door.

Distribution:

SAO: Dr. Golub
J. Gerdes
F. Licata
D. Boyd
P. Chelmets
B. Dias
J. D'Angelo

IBM: Dr. J. Wilczynski
Dr. E. Spiller



200 K BIT RATE
DIGITAL WORDS = 1250/SEC

FIGURE 1

NIXT TM FORMAT

Leon Holub

January 23, 1985

TO: 841.3/Payload Manager, Nike-Black Brant V 27.099 US

FROM: 841.1/Chairman, Payload Design Review Panel for Nike-Black Brant V 27.099 US

SUBJECT: Results of Payload Design Review for Nike-Black Brant V 27.099 US

A Preliminary Design Review was conducted for Nike-Black Brant V 27.099 US on January 23, 1985, at the Wallops Flight Facility. A list of attendees is presented as Enclosure 1. Launch is currently scheduled for May, 1986.

Members of the experiment team from the Smithsonian Astrophysical Observatory discussed the progress made in the experiment design since the Project Initiation Conference as well as several design elements which are yet to be refined. Enclosure 2 is the documentation provided for this purpose. On going discussion was held between the members of the project team concerning various design aspects such as the length and number of skin sections to be used, the required center of percussion, and the electrical and telemetry interfaces between the experiment and the SPARCS system. Thermal considerations were also discussed and Enclosure 3 was provided as evidence that no thermal damage should be incurred by the experiment.

A mission analysis presentation was made and is included as Enclosure 4.

It was evident that the experiment team has an excellent grasp of the design considerations and of the approach which they intend to take in completing the design. Further, it was expressed by the experiment and payload team that this meeting was intended to be a preliminary design review and not a review of the final design. This assuages the Review Committee's concern that there was no final design presented for review and that there are a number of design elements which have not yet been determined. So with the understanding that there will be a later Critical Design Review this Review Committee has no Action Items pertaining to this meeting.

Although it is not felt necessary to review standard flight systems such as the SPARCS, the Review Committee does feel it is desirable to review any aspects of these systems which are payload specific. In particular, the Review Committee recommends that the electrical system of the experiment and the electrical and telemetry interfaces between the experiment and SPARCS system be documented and presented at the Critical Design Review.

Philip R. Ward

Philip R. Ward

CONCUR:

H. T. Bell

H. T. Bell

H. F. Taylor

Ralph Bennie, 24 JAN 85

Ralph Bennie

Ralph D. Welsh

Ralph Welsh

Wayne D. Gunter

Wayne Gunter

cc: w/o enclosures
J. W. Gray/820.0
C. L. Lipsett/821.0
Z. B. Barfield/821.1
D. C. Mason/821.1
J. C. Bowman/821.2
T. J. Savage/822
W. W. West/822.3
R. A. Burns/822.4
D. F. Melvin/823.1
C. D. Leitao/823.1
F. R. Sawyer/824.0
J. L. Parks/824.1
J. F. Andrews/824.1
R. T. Duffy/830.0
C. F. Milliner/830.0
J. R. Duke/833.0
G. G. Morris/834.0
R. H. Pless/840.0
G. D. Paterson/840.0
L. W. Gurkin/841.0
D. F. Detwiler/841.1
C. W. Ballance/841.2
F. M. Boykin/841.3
Project Team
Review Panel Members
Attendees
SRPB Files (w/enclosures)

ENCLOSURE 1

PRELIMINARY DESIGN REVIEW

NIKE-BLACK BRANT V 27.099 US

JANUARY 23, 1985

LIST OF ATTENDEES

Leon Golub	Smithsonian Astrophysical Observatory	Experiment Team
George Nystom	Smithsonian Astrophysical Observatory	Experiment Team
Frank Licata	Smithsonian Astrophysical Observatory	Experiment Team
Philip R. Ward	GSFC/WFF/841.1	Chairman, Review Panel
Hartwell F. Taylor, Jr.	GSFC/WFF/822.3	Panel Member
Ralph F. Bennie	CSC	Panel Member
Ralph D. Welsh, Jr.	GSFC/WFF/822.4	Panel Member
Holland T. Bell	GSFC/WFF/822.3	Panel Member
Wayne D. Gunter	GSFC/WFF/824/1	Panel Member
Frank Lau	GSFC/WFF/841.2	Project Manager
Robert P. Buchanan	GSFC/WFF/841.1	Project Team
Harold J. Zimmer	LMSC	Project Team
Tom Laughlin	LMSC	Project Team
Fred Lemon	LMSC	Project Team
Ray H. Pless	GSFC/WFF/840.0	
L. Warren Gurkin	GSFC/WFF/841.0	
Carl W. Ballance	GSFC/WFF/841.2	
James F. Andrews	GSFC/WFF/824.1	
Robert A. Burns	GSFC/WFF/822.4	
William T. Wallace	GSFC/WFF/822.4	
Robert J. Flowers	GSFC/WFF/841.2	

SMITHSONIAN INSTITUTION
ASTROPHYSICAL OBSERVATORY
60 GARDEN STREET CAMBRIDGE, MASSACHUSETTS 02138
TELEPHONE 617 495-7000

February 6, 1985

Dr. William T. Wallace
Mail Code 022.4
Wallops Flight Facility Center
National Aeronautics and Space Administration
Wallops Island, Virginia 23337

Dear Bill:

I have revised our rocket skin drawing for sections 2, 3 and 4 per our discussions yesterday. Two prints of each are enclosed for your use.

Best Wishes,

George Nystrom

GN:pk
Enclosures

cc: Dr. Golub w/o enclosure

SMITHSONIAN INSTITUTION
ASTROPHYSICAL OBSERVATORY
60 GARDEN STREET CAMBRIDGE, MASSACHUSETTS 02138
TELEPHONE 617 495-7000

February 6, 1985

Mr. Ralph Welsh
Mail Code 1022.4
Wallops Flight Facility Center
National Aeronautics and Space Administration
Wallops Island, Virginia 23337

Dear Ralph:

Enclosed is a copy of our program to compute moments and products of Inertia. A sample of our input to the program is also included to help you.

We break things into 4 pieces when symmetrical to axis, i.e., primary mirror, etc.

Best wishes,

George Nystrom

GN:pk
Enclosure

cc: Dr. Golub w/o enclosure

SMITHSONIAN INSTITUTION
ASTROPHYSICAL OBSERVATORY
60 GARDEN STREET CAMBRIDGE, MASSACHUSETTS 02138
TELEPHONE 617 495-7000

12 February 1985

Dr. Janus Wilczynski
IBM T. J. Watson Research Center
Box 218
Yorktown Heights, NY 10598

Dear Janus,

We recently completed a preliminary design review at the NASA-Wallops Island Flight Facility. I have included a copy of the meeting minutes, our presentation material and the WFF aeroballistic analysis.

Presently, the primary mirror mount has been redesigned to a conventional system. It is as we discussed and is shown on the updated system drawing enclosed. The parts are presently in the manufacturing cycle with delivery expected the end of February. The design will be tested the first week of March using the IBM pyrex blank. We feel confident this design will satisfy the optical, coating and mechanical requirements. Optically it is a rigid Kinematic positioning scheme which is insensitive to thermal and mechanical distortions. Coating is facilitated by easy removal and re-assembly of the optic. The optic is positioned mechanically by applying a compressive force across the optics thickness with radical positioning achieved by a combination of the frictional resistance of the axial mount and radial shims. These radial shims are at three locations bonded in place with G.E.-RTV 108 adhesive. The intent is to minimize radial loads to the optic, while guaranteeing that it can not decenter beyond the allowable tolerance. Enclosed also is the Zyglo photograph of the clamping test Peter and Steve ran. It indicates that distortions from applied compressive forces are minimal.

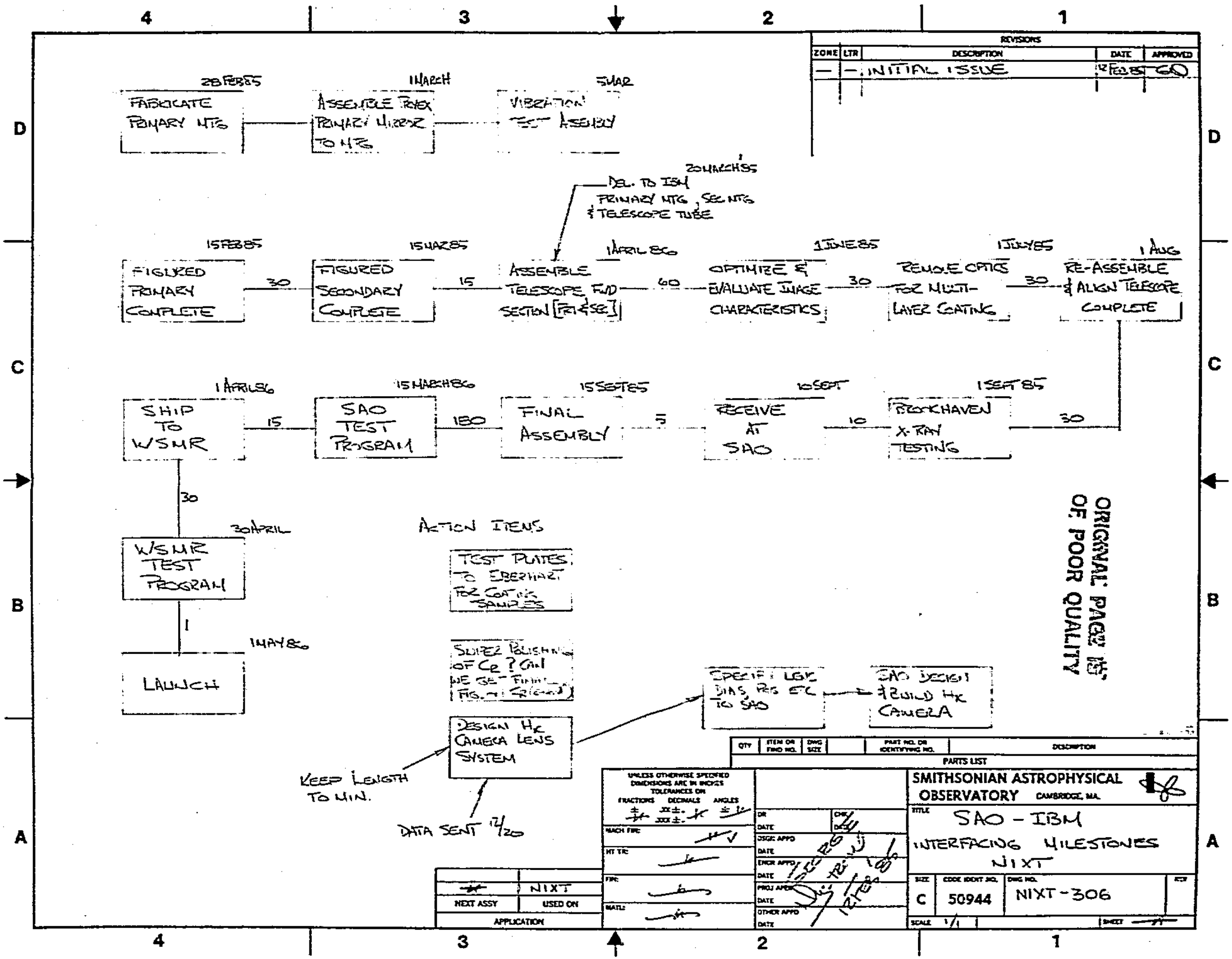
I have relaxed the SAO/IBM interface dates somewhat based on the mirror mount redesign. The new interface dates are shown on the enclosed PERT diagram. Please review and discuss them with Eberhart to see if they are realistic for you.

Yours sincerely,

George U. Nystrom

GUN/mk
Enclosures

cc: Dr. L. Golub
Mr. J. Gerdes
Dr. E. Spiller, IBM, w/enclosures



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OF POOR QUALITY

2. NIXT Electronics Design

MEMORANDUM

To: Dr. L. Golub and G. Nystrom

From: J. D'Angelo/F. Licata

Date: [illegible], 1985

Subject: NIX-T Electronic Design

This memorandum together with the referenced drawings represents the current state of the NIX-T Electronic Design. The design utilizes a hardwired logic approach with an EEPROM used for programming of the exposure code sequence. A data encoder will provide the interface, through the umbilical cable for monitoring of the analog and digital housekeeping data while the payload is on the ground by means of the SAO GSE console. NASA will provide the encoder for the inflight telemetry and the required displays during flight.

Primary scientific data is recorded on film which will be recovered from the rocket at the conclusion of the flight. Housekeeping data is transmitted to the ground over a telemetry link and stored on tape for post flight analysis.

A telemetry command link will provide four discrete commands for use in the payload. The commands are in the form of contact closures.

A Video camera with an H-ALPHA filter will be provided by SAO. A separate high frequency telemetry channel will transmit the camera data. NASA will provide the wide band transmitter.

Electronics System Overview

Drawing No. NIXT-218 shows the block diagram for the NIXT system. The command telemetry, data telemetry, telemetry interface, camera battery, electronics battery, and video telemetry are supplied by NASA. The experiment will be powered by a 28V battery. A 6V tap will be used to power the camera. The full 28V will go to a DC/DC converter that will produce the ±15V and 5V regulated voltages for use by the electronic package. NASA will provide and service the battery as required. A magnetic latching change over relay will switch the experiment to External/Internal power. Battery power will be applied to the experiment a few minutes before launch. External power will be used for most of the testing.

The electronic package will be housed in a separate rocket section. Adequate doors will be provided to permit servicing of the electronic modules even after final assembly to the booster. This compartment will not be pressurized. The GSE console will be connected to the experiment via the umbilical connector and the range provided cables (approximately 900ft). 20 lines are reserved for SAO use and will be made available at the block house. The umbilical lines available through the NASA interface for use by the GSE are:

1 Internal/External power, commands and monitor (10 lines) as follows: 2 lines + 28V, 2 lines + 6V, 2 lines return, power INT/EXT commands and monitor 4 lines.

2 Light Test, - provide excitation for the ~~two~~ test light source which is used prior to launch to check for light leaks through the filter 1 line. A test film pack will replace the camera. This pack will contain a light detector whose output

will be displayed on our GSE.

3 Camera Test, - contact closure operates camera shutter. (2 lines)

4 GSE Telemetry, - provides housekeeping data to the GSE console. (4 lines)

5 Lift Off simulator, - contact closure to generate a lift signal and allow system operation during testing. (2 lines)

Inflight housekeeping data will consist of 4 digital words and 29 analog words as summarized below.

Digital Word #1 - Bit 0 thru 7 - Frame No., Bits 8, 9 spares

Digital word #2 - Exposure Time to 1% resolution.

Count of 100 = 100% of nominal exposure time.

Digital Word #3 - Bit 0 thru 7 - exposure code, Bits 9, 10 spares

Digital word #4

Bit 0 - Shutter, O/C

Bit 1 - 1 Hz signal

Bit 2 - Lift-off,

Bit 3 - Sequence enable

Bit 4 - Restart

Bit 5 - Abort

Bit 6 thru bit 9 - spares

Analog Word #1 - Light Sensor Level

Analog Word #2 thru #4 - spares

Analog Word #5 - Pressure Sensor

Analog Word #6 - Camera Current Monitor

Analog Word #7 thru #10 - Temperature Sensors (4)

Analog Word #11 thru #16 - Circuit Voltage Monitors (5)

Analog Word #17 & #21 - Temperature sensors (4)

Analog Word #22 H - Alpha filter temperature

Analog Word #23 - thru 29 spares

Inflight housekeeping data is transmitted to the ground over a data telemetry link operating at 200 KBit per second. Each word is 10 bits in length, a subframe consists of 32 words and a frame contains 32 subframes. Thus, there is a total of 10,240 bits per frame, the frame time is 51.2 milliseconds and the subframe time is 1.6 milliseconds. Since time is recorded at the start of each subframe, our time accuracy will be 1.6 millseconds. Digital data utilizes all 10 bits of a word. Analog data is converted to digital form by a 9 bit successive approximation analog-to-digital converter and outputed as the first 9 bits of a word. Odd parity is calculated on these 9 bits and is outputed as the tenth bit.

Electronics System Operation

Following lift-off, the sun acquired signal from SPARCS (Solar Pointed Aerobee Rocket Control System) is continuously monitored. When sun acquired goes true (contact closure) the automatic sequence of exposures is enabled. In the event that sun acquired does not go true prior to 100 seconds following Lift-Off the automatic sequence will be enabled by the 100s timer. Once the sequence is enabled, it will continue regardless of the sun acquired signal.

The normal mode of operation involves a series of preprogrammed exposure times that occur automatically once the sun acquired signal goes true or the 100 second timer runs out. In addition to the normal mode of programmed exposure times, the system responds to a "RESTART" command and an "ABORT" command.

The RESTART command terminates an exposure in progress by closing the shutter and advancing the film. However, the exposure code remains unchanged and a new exposure is started with the same exposure time as the exposure that was interrupted.

The ABORT command locks out the automatic programmed exposure sequence and the shutter is controlled directly by the abort signal. 2 contact closures perform this functions an enable contact closure and a shutter open/close contact.

Drawing No. NIXT 216 is a simplified diagram of the camera logic circuits described by function in the following paragraphs.

The experiment clock utilizes a 1 MHz crystal oscillator followed by cascaded decade divider chains to produce signals in the range of 10 KHz to .01 Hz (100 SEC). The entire camera logic is held reset until lift off occurs. Following lift off the counters begin operation and all the camera logic circuits are enabled.

The cycle control circuit provides a shutter gate signal that determines the time during which the camera shutter is commanded open. After lift OFF, when either, sun acquired signal is received or 100 seconds have elapsed Flip/Flop U6A is set thereby enabling the "D" input of U16A. The leading edge of the first 1 Hz clock pulse then sets U16A which generates the shutter gate. The shutter gate also generates a short duration pulse which resets the exposure counter. The clock for the exposure counter is selected by the programmer which consists of an 8 bit counter (PROM address generator) the PROM and the data selector chip (MUX). Since the PROM address counter was reset to zero and the first exposure is ten seconds, the code returned is 03 and the data selector applies the 10 Hz clock to the exposure counter. At the count of 100 the STOP signal appears, which resets the shutter gate F/F U16A and advances the PROM address counter. When the shutter closes the camera automatically advances the film and the "CAMERA READY" signal goes low. At the completion of the camera cycle, the "CAMERA READY" signal goes high and U16 F/F is set by the first 1 Hz pulse. This starts a new exposure cycle. The frame counter is advanced one count at the leading edge of the shutter gate signal.

A sample exposure sequence is shown below:

EXP #	DURATION	PROM CODE (OCTAL)	CLOCK
1---5	10 sec	03	10 Hz
6---8	3 sec	12	100 Hz : 3
9---18	1 sec	02	100 Hz
19---21	10 sec	03	10 Hz
22	30 sec	13	10 Hz : 3
23	100 sec	01	1 Hz
24---26	10 sec	03	10 Hz
27---36	1 sec	02	100 Hz

Total exposure time 269 sec, 36 total exposures. The PROM and program counter have a capability of 256 different exposures. The camera will continue in operation during reentry and until film runs out. No automatic stop is contemplated at this time.

GSE TELEMETRY While the payload is on the ground the housekeeping data will be monitored on the GSE console via the umbilical cable. Line drivers and receivers will be used to interface the data lines to the umbilical connector and approximately 900 feet of cable from the launch pad to the block house. A much shorter cable will be used for bench testing on the payload.

A separate encoder is used for the GSE telemetry data. A reference clock is also generated on the payload and supplied to the GSE. See DWG NIXT 217. The GSE housekeeping data will consist of 16 digital words and 16 analog words of 10 bits each and a clock frequency of 1 KHz. The frame rate is therefore approximately 1/3 seconds. The telemetry format is summarized below:

Digital Word #1 - Synch 1, EX $0B8

Digital Word #2 - Synch 2, EX $357

Digital Word #3 - Bit 0 thru 6 - Frame No., MSB monitors camera test.

Digital word #4 - Exposure Time to 1% resolution.
Count of 100 = 100% of nominal exposure time.

Digital Word #5 - Status

- Bit 0 - Shutter, 0 = closed, 1 = open
- Bit 1 - Lift-off, 0 = pre lift-off, 1 = post lift-off
- Bit 2 - Sun Acquired, 0 = false, 1 = true
- Bit 3 - Restart, 0 = not activated, 1 = activated
- Bit 4 - Abort, 0 = not activated, 1 = activated
- Bit 5 - 1 Hz Clock signal
- Bit 6 thru bit 9 - Exposure Code

Digital Word #6 - TBD (spare)

Digital Word #7 - 32 Not used.

Analog Word #1 - Light Sensor Level

Analog Word #2 thru #4 - spares

Analog Word #5 - Pressure Sensor

Analog Word #6 - Camera Current Monitor

Analog Word #7 - H Alpha Filter Temperature Monitor

Analog Word #8 thru #10 - Temperature Sensors (3)

Analog Word #11 thru #14 - Circuit Voltage Monitors (4)

Analog Word #15, #16 - Battery Voltages

Each of the analog voltages will be scaled to a range of 0 to 5V and encoded in a ten bit straight binary code. The GSE will be able to selectively display any of the telemetry words. In addition, the following words will be hard wired for continuous display.

Battery 1, and 2 volts.

Synch (Light)

Frame Counter

Status Bits (SHTR O/C, ABORT, 1 Hz)

Exposure time.

INT/EXT Power

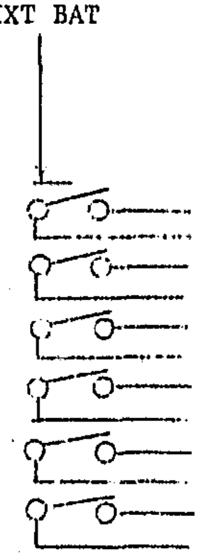
During the rocket flight the GSE console will not be operational. NASA will provide vital telemetry data as requested by SAO

FL/JA:pk

PRELIMINARY

ICD NIXT PAYLOAD

INTERFACE SPECIFICATIONS GSFC/NIXT



GSFC	SIGNAL DESC	J1=MS3112E-20-41P NIXT
NIXT BAT	+28V BATTERY	J1-A
	" "	"-B
	+ 6V "	"-C
	" "	"-D
	RTN "	"-E
	" "	"-F
	CMD 1	"-G
	RTN "	"-H
	CMD 2	"-J
	RTN "	"-K
	CMD 3	"-L
	RTN "	"-M
	CMD 4	"-N
	RTN "	"-P
	LIFT OFF SIGNAL	"-R
	RTN " "	"-S
	SUN ACQUIRED	"-T
	RTN "	"-U
UMBILICAL	+28V GSE PWR	"-V
"	+ 6V "	"-W
"	RTN "	"-X
"	LIGHT 1 TEST	"-Y
"	LIGHT 2 TEST	"-Z
"	RTN "	"-a
"	PWR EXT CMD	"-b
"	PWR " MON	"-c
"	PWR INT CMD	J1-d
"	" " MON	"-e
"	RTN "	"-f
"	GSE DATA +	"-g
"	" " -	"-i
"	GSE CLK +	"-j
"	GSE CLK -	"-k
"	CAMERA TEST	"-m
"	MASTER RST	"-n
"	RTN "	"-p
NC	SPARES	"-q
"	"	"-r
"	"	"-s
"	"	"-t

TELEMETRY SUBFRAME AND WORD ASSIGNMENT

SUBFRAME 1 ?

WORD ØØØØØ (BINARY), DIGITAL Ø

BIT		DDMA-50S
Ø		J2-1
1		"-2
2	FRAME	"-3
3	COUNTER	"-4
4		"-5
5		"-6
6		"-7
7	MSB	"-8
8	MON	"-9
9		"-10

WORD 00001, DIGITAL 1

BIT		
Ø		J2-11
1		"-12
2		"-13
3		"-14
4	EXPOSURE	"-15
5	TIME	"-16
6		"-17
7		"-18
8		"-9'19
9		"-20

WORD 00010, DIGITAL 2

BIT		
Ø	SHUTTER OPN/CLS	J2-21
1	LIFT OFF	"-22
2	SUN ACQUIRED	"-23
3	RESTART	"-24
4	ABORT	"-25
5	1 HZ	"-26
6		"-27
7	EXPOSURE	"-28
8	CODE	"-29
9		"-30

WORD 00011, DIGITAL 3

BIT		
Ø		J2-31
1		"-32
2		"-33
3		"-34
4	SPARE	"-35
5		"-36
6		"-37
7		"-38
8		"-39
9		"-40

ANALOG SIGNALS ALL 0-5V single ended

WORD	4-10	NOT USED			J2-41-50
WORD	11	ANALOG		TEMP 1	J3-1 (DMA-50S)
"	12	"		" 2	"-2
"	13	"		" 3	"-3
"	14	"		" 4	"-4
"	15	"		" 5	"-5
"	16	"	0	LIGHT SENSOR	"-6
"	17	"	1	ACCEL X	"-7
"	18	"	2	ACCEL Y	"-8
"	19	"	3	ACCEL Z	"-9
"	20	"	4	PRESSURE	"-10
"	21	"	5	CAMERA CURRENT	"-11
"	22	"	6	TEMP 6	"-12
"	23	"	7	" 7	"-13
"	24	"	8	" 8	"-14
"	25	"	9	" 9	"-15
"	26	"	10	+15V MON	"-16
"	27	"	11	-15V MON	"-17
"	28	"	12	+5V MON	"-18
"	29	"	13	+VOLTS	"-19
"	30	"	14	+28V BAT	"-20
"	31	"	15	+6V BAT	"-21
				RETURN	"-22
				ANALOG	"-23

BOOSTER & SPARKS J4 ?

H-ALPHA CAMERA J5

MEMORANDUM

TO: G.Nystrom/F.Licata

27 NOvember 1984

FROM: D.Boyd DB

DAR-84-031

SUBJECT: Temperature Sensors and Thermal Coatings for NIXT

CC: B.Dias, L.Golub

The Analog Devices AD590 temperature sensor will be used for NIXT; nine will be required, located as specified below. We should have a maximum error of 3°C in the device, which requires an AD590J if each sensor has an individual calibration adjustment built into the circuitry, or an AD590L if there is no calibration adjustment (probably the most economical). Either the TO52 or flat-pack style is satisfactory; the former is probably more rugged and easier to terminate.

Locations of the sensors:

- Two in the electronics--Frank Licata to choose locations
- Three on the telescope:
  - One immediately behind the secondary mirror on the support post
  - One on the primary flange adjacent to a main bolt
  - One on the primary flange midway between two bolts
- Four on the inner surface of the rocket skin:
  - One immediately adjacent to the same bolt as above
  - Three located 120° apart at station 55±5

The external surface of the rocket skin should be anodized to a minimum thickness of 0.2 mils; any amount thicker is OK subject to smoothness requirements for the skin. Color is unimportant. The inner surface of the skin should be bare aluminum if possible; Chromacoat or equivalent is marginally OK but anodizing is not permitted. The outer and inner surfaces of the thermal shield tubes should also be bare aluminum.

3. Mirror Assembly Shake Test

MEMORANDUM

To: Distribution Date: 6 November 1984

From: Peter Cheimets

Subject: NIXT Mirror Assembly Shake Test

The NIXT primary mirror was subjected to a vibration test. The Zerodur glass blank cracked during an optical directions sine sweep. Possible scenarios for the failure are discussed below, along with suggested future action.

The test conducted on October 29, 1984 at Stanford Technologies was the second battery performed on the structure. During the first set of tests the mirror failed while being subjected to random vibration in the optical direction.

The mirror bonding lands on the invar base ring were remachined as discussed in a memo written after the last tests. This machining reduced the effective strength of the ring, as viewed by the mirror. Further, a more complete bond area was accomplished by assuring that the epoxy did not sink prior to cure (a problem mentioned in the memo). It was assumed that these steps would improve the mirror assembly's resilience. The invar flange that will form the base of the secondary tube was also bolted to the base ring. It was felt that this would stiffen the ring while better matching the final system.

The structure was first tested in the cross optical axis. A 4-g maximum sine sweep was run to identify resonances. After the shake system was gotten to work this sweep was made uneventfully. The full 15-g maximum test was then run. A strong resonance was encountered at 1300 Hz. The shaker could not drive through it. The run was completed by starting at 2000 Hz and running down. The shaker shut down again at 1300 Hz. The 19.5-g random test was run. After each of these tests the bond was checked and no functional changes were observed.

The system was then setup to test the optical axis. Once again a 4g maximum sine sweep was run to search for modes. A strong primary mode was found at 561 Hz and family of resonances were recorded around 1100. One of these peaked at 14g's while being subjected to 4g's of input vibration. In spite of this we went ahead with the full 15g level sine survey. The run went well until 830 Hz when the system shut down, apparently because the control accelerometer came off. When the mirror was examined we found that the glass had broken around two mirror supports. The damage was too bad to continue.

The amplitude vs. frequency plots of the two sets of tests performed are attached. Figure 1 shows the intended acceleration levels. Figures 2 and 3 show the 4-g resonance surveys in the cross optical (radial) and optical (vertical) directions respectively. The strong resonances are visible. The drop out in the radial graph is due

to 60 Hz noise, a problem with the equipment. The 4g results are much noisier than the 15g as the signal is too small to extend far above the background noise. Figures 4 and 5 show the sine sweeps at full accelerations in the cross optical direction. Figure 4 is from the first set of test figure 5 from the second. Figures 6 and 7 show the optical axis sweeps, first and second test respectively. Figure 7 ends abruptly at the point the accelerometer came off, presumably when the mirror broke.

Figures 8, 9 and 10 are the random tests that have been run to date. Figures 8 and 9 are from the first tests, figure 10 is the cross optical from the second set.

Possible Cause

The exact cause of the failure is not clear. We are unsure if the breakage is related to: a resonance that was too strong for the glass, a disconsonant mode between the mirror and the ring, an artifice of the test (the acceleration level jumped at 800 Hz, as prescribed, this may have induced very high strains during the transition) or the result of the system response to the control accelerometer disconnecting (the driver may have sent a very large acceleration to the shaker since it was receiving no signal back). Re-examination of the mount arrangement have not yielded any insight to date. The results still indicate that the design is viable, with a large safety factor.

Possible Solution

One thing that seems reasonable to say is that the constraint of the adhesive is central to the problem. The glass away from the bond was not broken. In the second test there were even flaws in the glass at which breakage could have initiated. The glass away from the bond area is neither constrained nor driven by the epoxy. The epoxy that was used, Hysoil 9313, cures very hard. Its quoted strength is 4000 PSI, twice the rule of thumb ultimate strength of the glass. Its modulus is about $.5 \times 10^6$ PSI within a factor of 25 of the glass. By using a weaker and less stiff adhesive the bonding locations will appear less constrained. The bonded areas of the glass will behave more like the unbonded areas, which have not failed.

If the problem is test related softening the adhesive may also help. However, in the third test transitions between acceleration levels will be ramped over 25-50 Hz. The control accelerometer will be bolted on rather than glued.

Other changes that resulted from this work: the mounting holes in the base ring will be moved. They had been drilled in the ring on the radial line behind each bonding pad. The initial design called for them to be clocked 60° away, half way between the pads. The effect of this is unclear though it means that the mirror will be less stiffly held to the shake table. Inserts will be placed in the mounting holes to adapt to the mounting bolts. This should better match the designed system and reduce some of the low end resonance encountered in the cross optical tests.

More instrumentation will be used this time around. A video camera may be used to record possible breakage.

Due to expense, IBM will provide us with a Pyrex blank rather than Zerodur. Pyrex is a little less stiff. We will increase its cross section so that the resulting EI will be the same as Zerodur. The edge of the glass will be acid etched to remove stress risers.

The problem is still being examined and the next steps are still unclear. However, I see no reason that our present course should not be effective.

Distribution:
- J. Aurilio
- D. Boyd
- L. Cohen
- R. B. Dias
- L. Golub (2) ✓
- G. Nystrom
- D. Rose
- File (5)

FIGURE: 3.
REFERENCE:

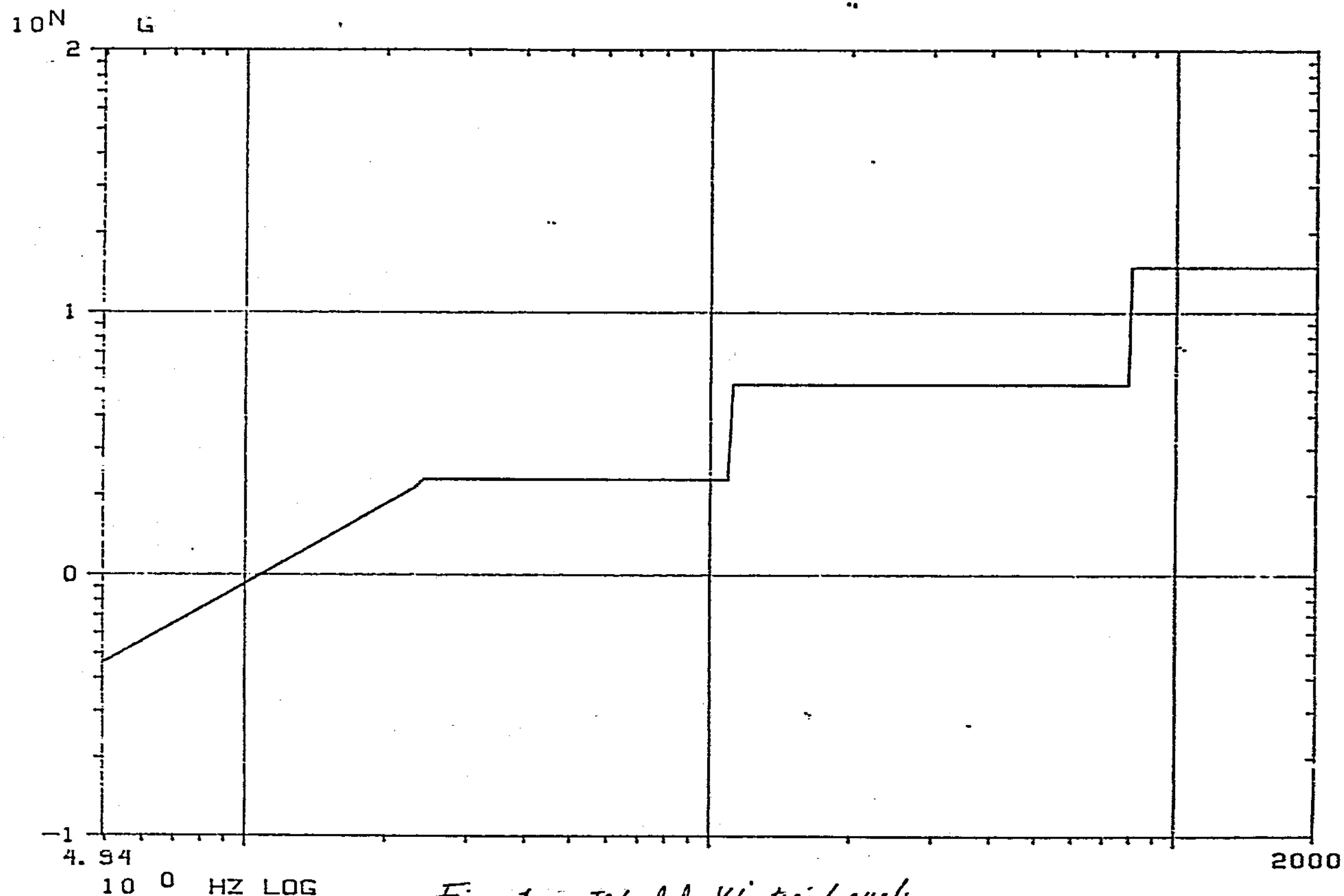


Fig. 1 Intended Vibration Levels

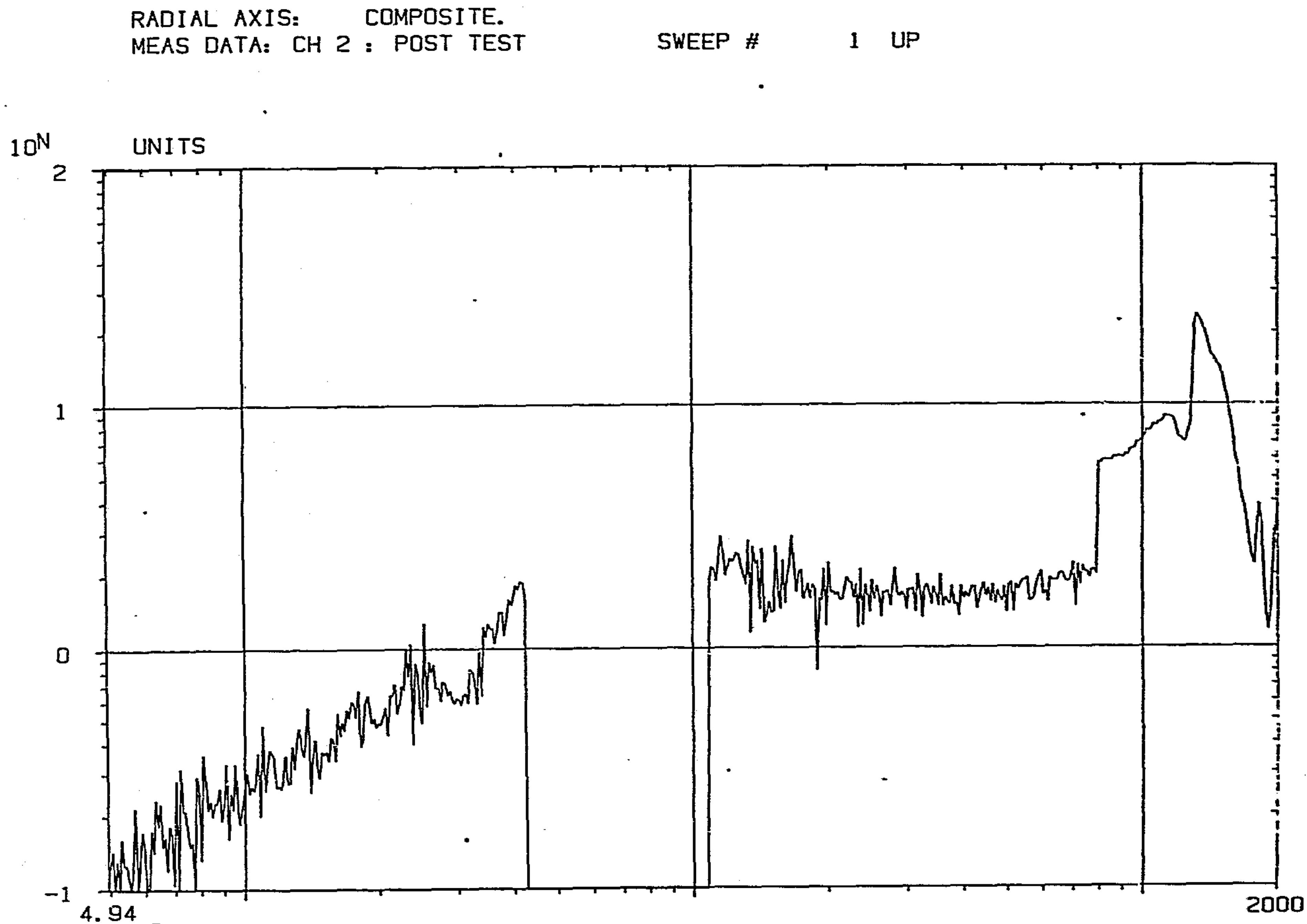


Fig 2 4-g Resonance Survey Cross Optical Direction

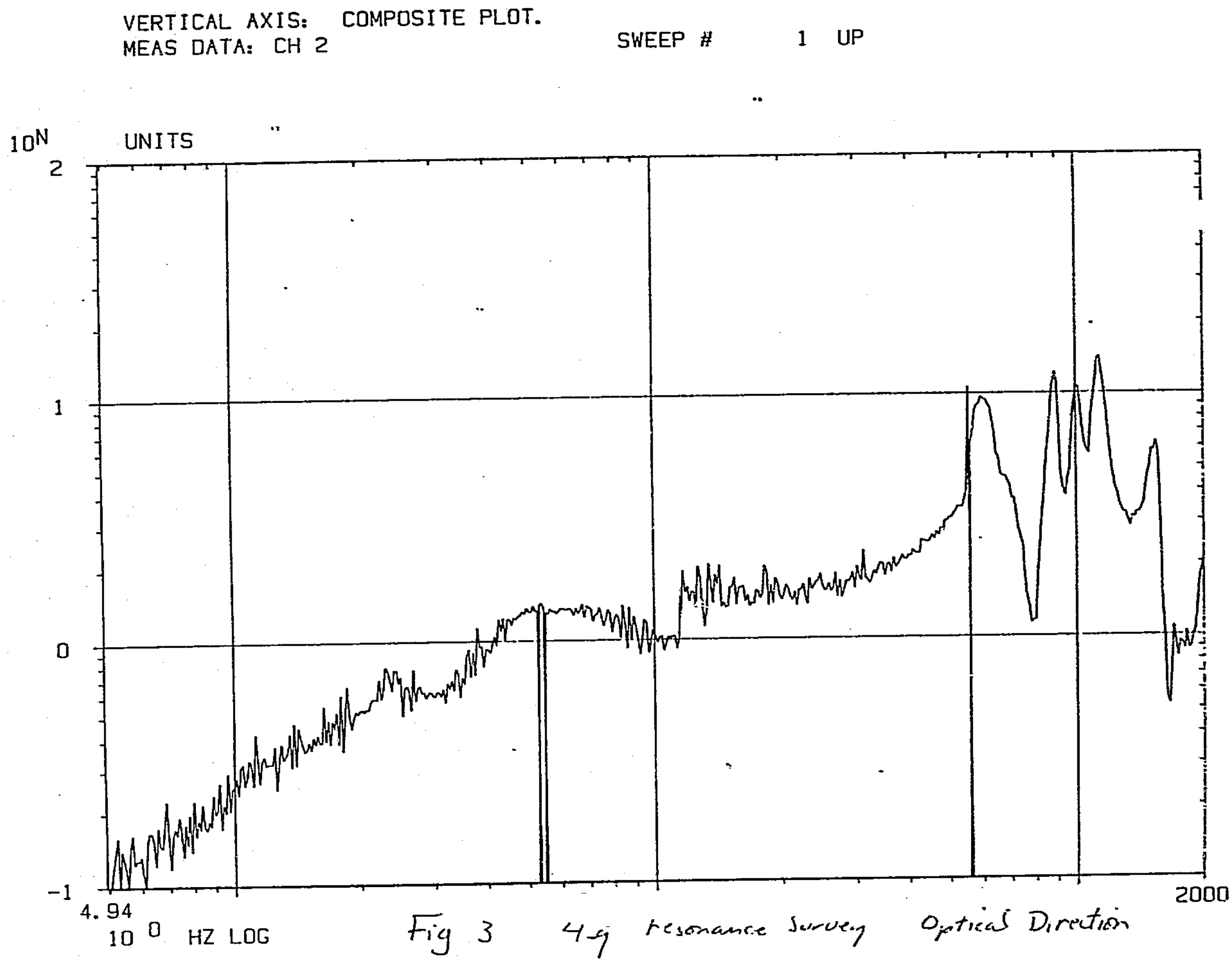


Fig 3 4g resonance Survey Optical Direction
2nd Test

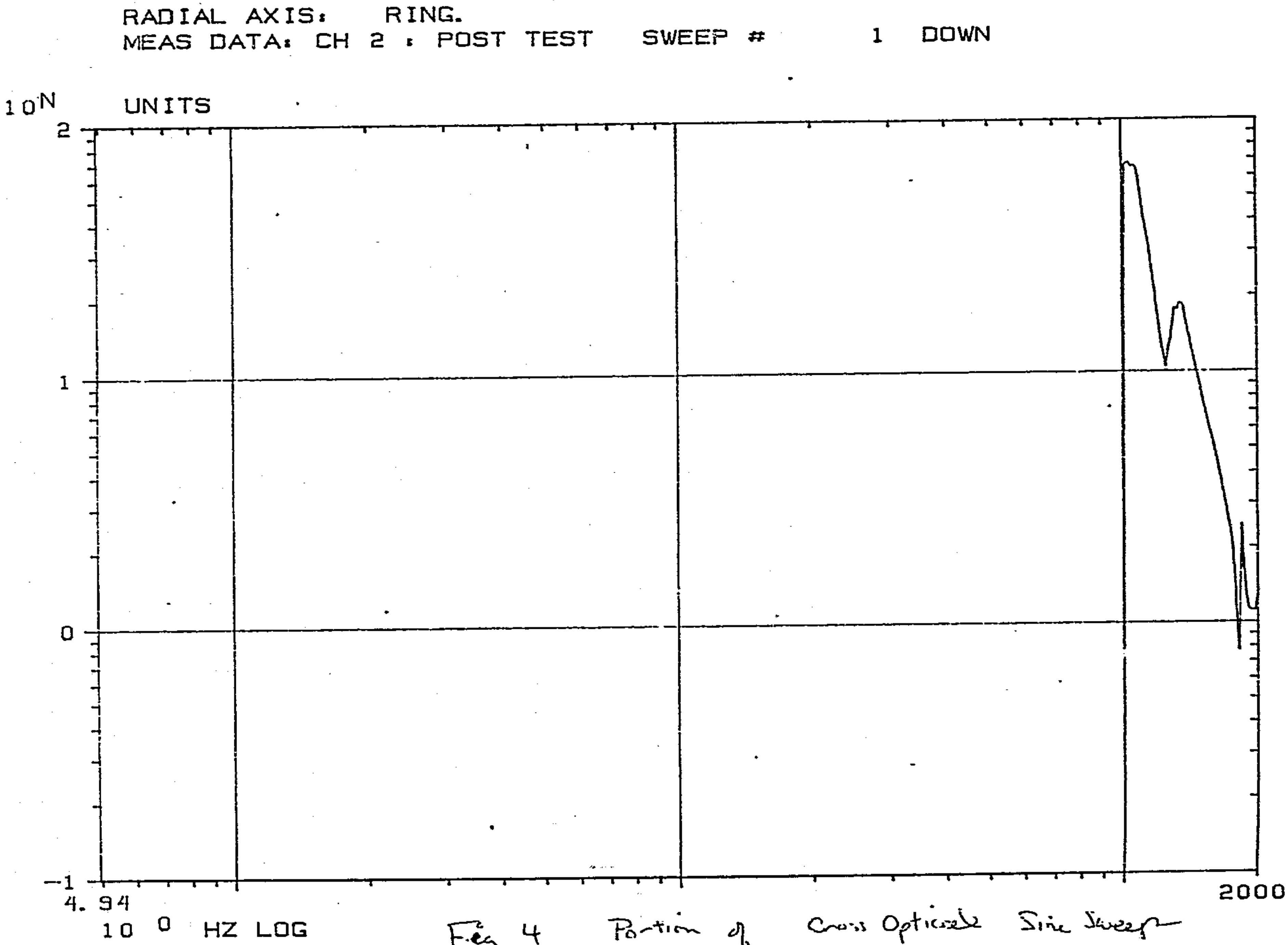


Fig 4 Portion of Cross Opticade Sine Sweep
other data test. 1ST Test

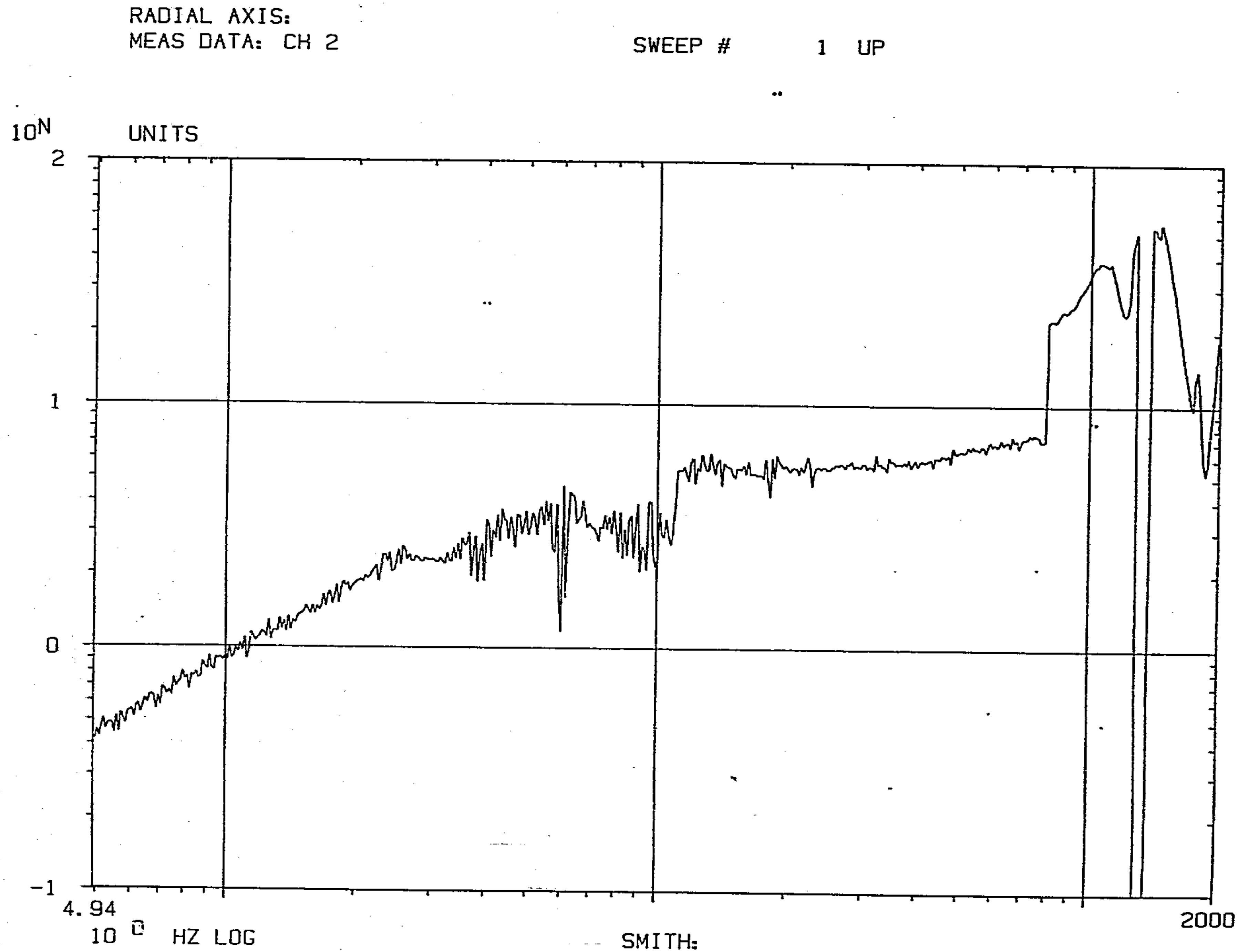


Fig 5 Sine Sweep Cross Optical 2nd test

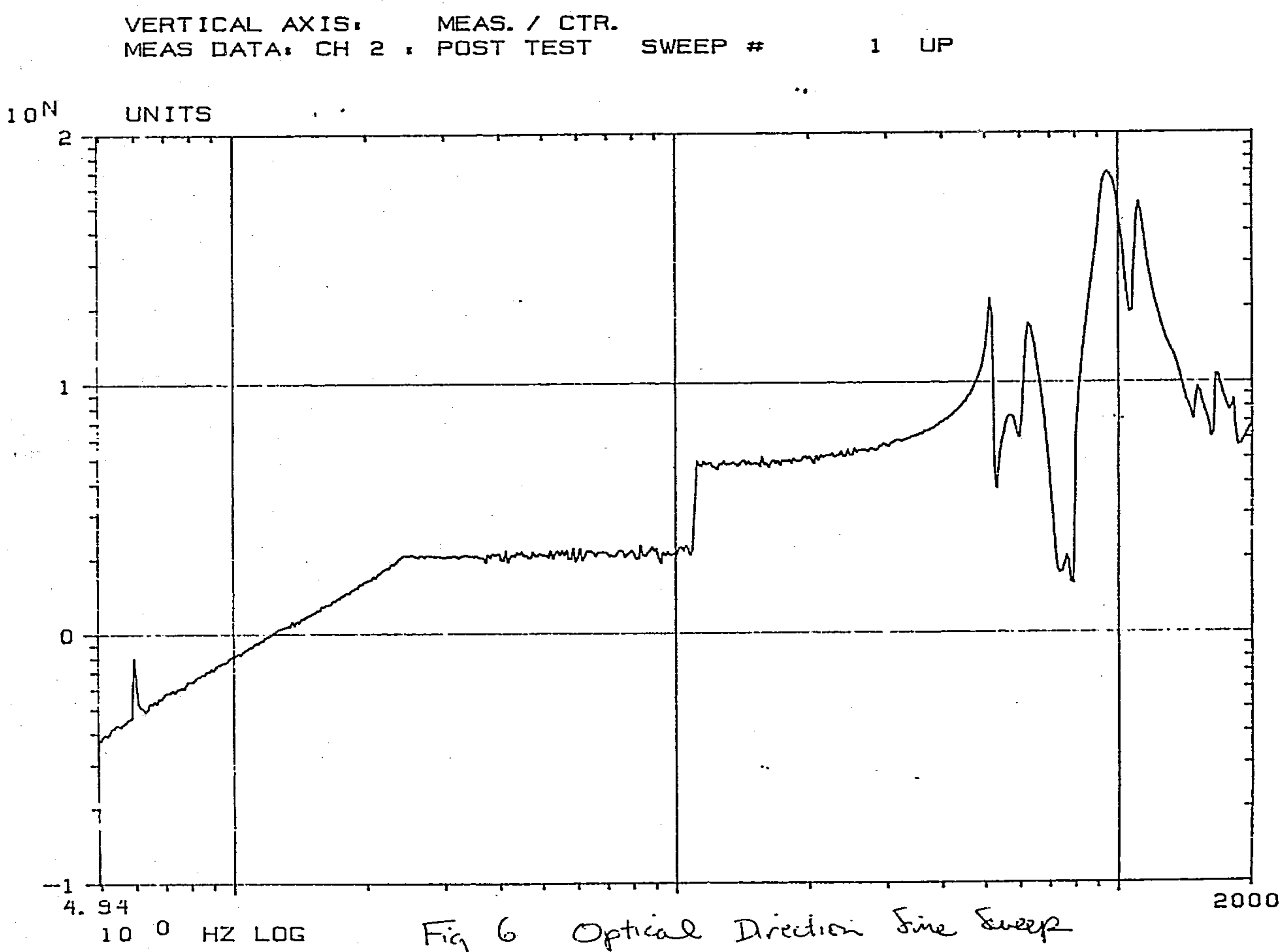


Fig 6 Optical Direction Sine Sweep
1st Test

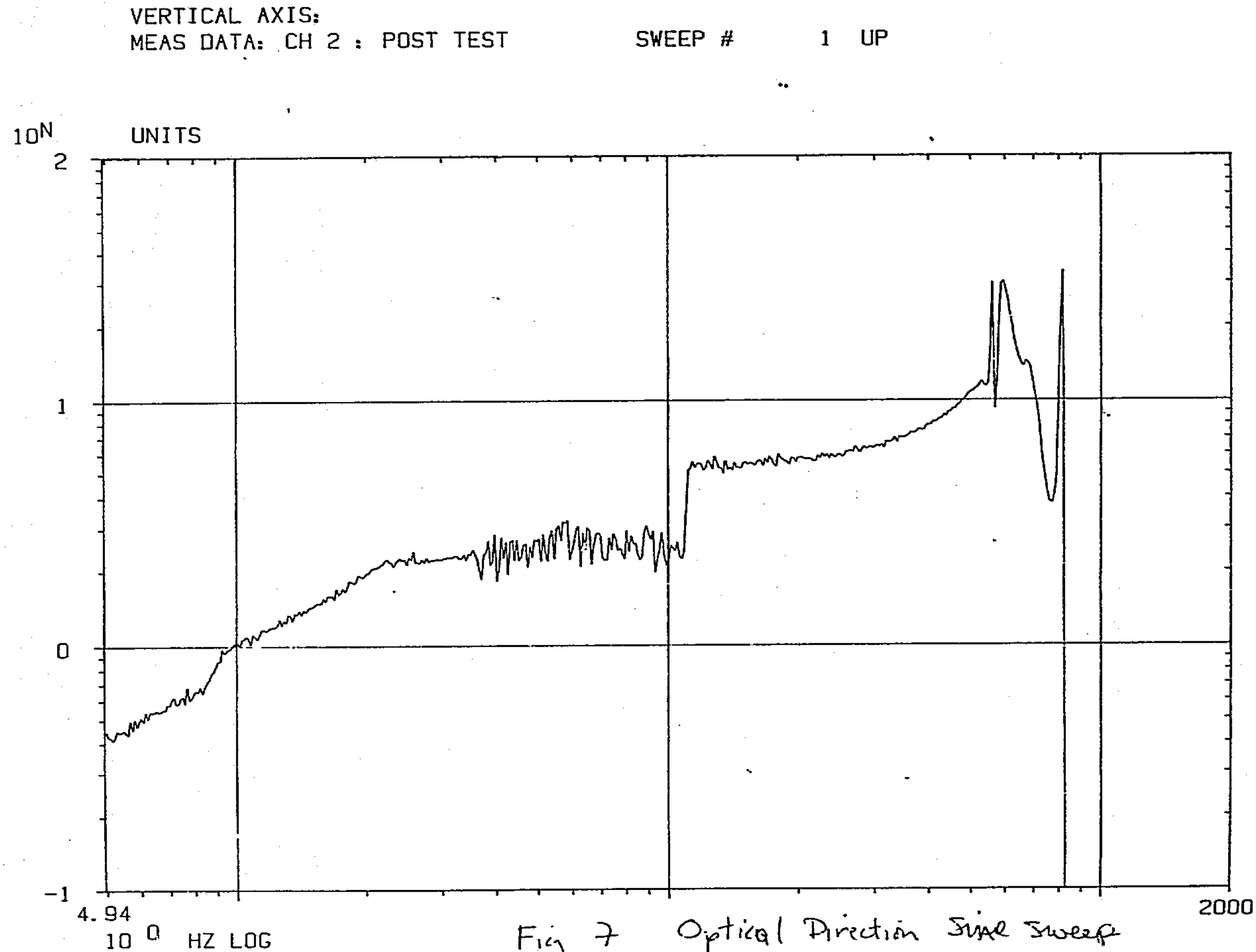


Fig 7 Optical Direction Sine Sweep
2nd test note Failure

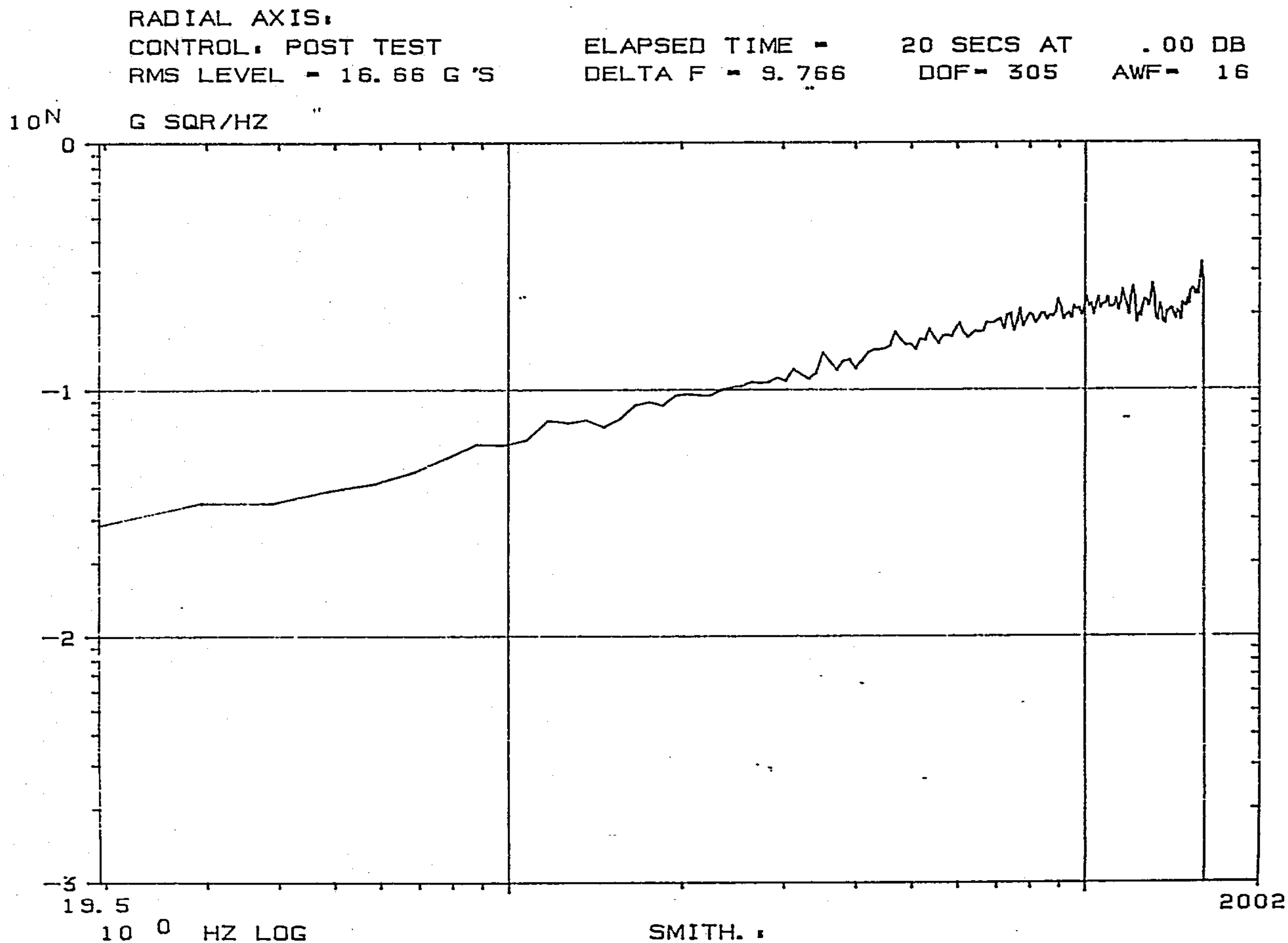
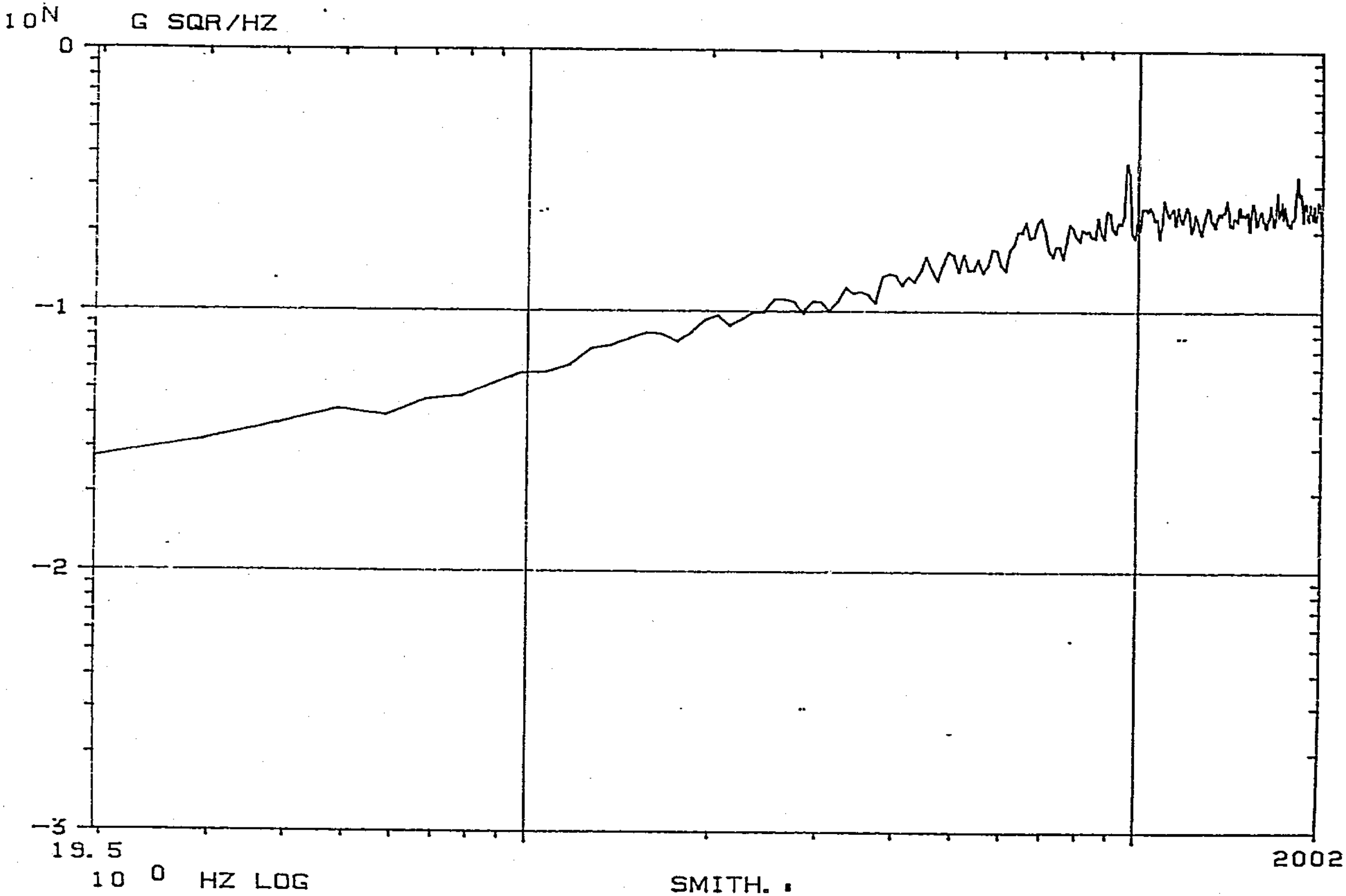


Fig 8 Cross Optical Random Test 1ST Test

VERTICAL AXIS:
CONTROL: POST TEST
RMS LEVEL = 19.58 G'S

ELAPSED TIME = 20 SECS AT .00 DB
DELTA F = 9.766 DOF= 304 AWF= 16

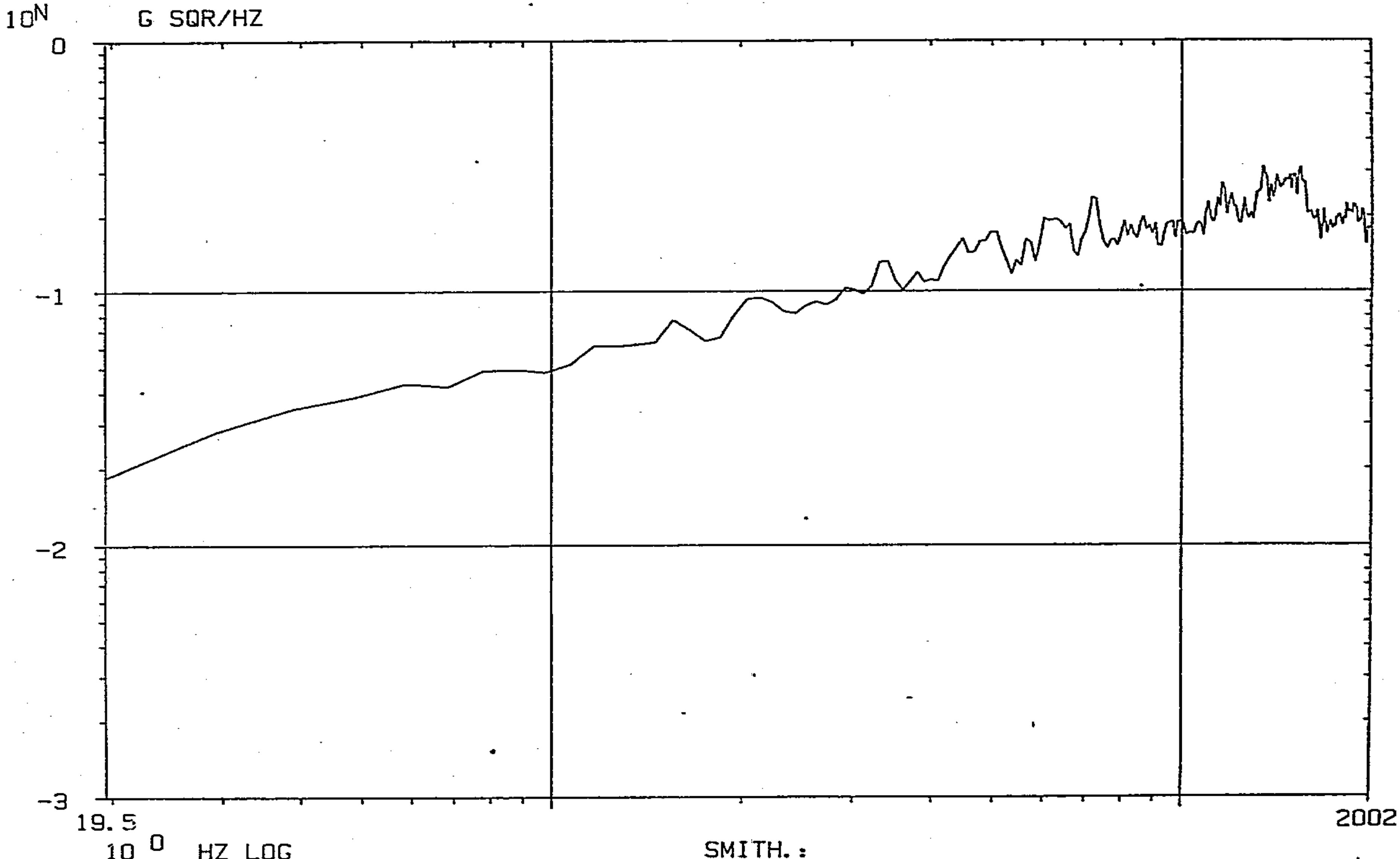


SMITH.

Fig 9 Optical Random Shake 1st Test

RADIAL AXIS:
CONTROL: POST TEST
RMS LEVEL = 18.67 G'S

ELAPSED TIME = 20 SECS AT .00 DB
DELTA F = 9.766 DOF= 305 AWF= 16



SMITH.:

Fig 10 Cross Optical Random test 2nd test

TO: George Nystrom
Leon Golub

FROM: Peter Cheimets PC

DATE: 11 March 1985

SUBJECT: Vibration Specification for Nixt Primary Mirror - Rev 3

SCOPE:

This specification describes the test procedure for shaking the NIXT primary mirror assembly to create conditions resembling those expected during launch. The test, setup, required equipment, personnel and reported data are outlined.

TEST ARTICLE:

The 1 mirror ring (NIXT-1000, Rev D) with a flat pyrex mirror blank having a central hole will be mounted in place and subjected to vibration loads shown graphically in figure 1 and described in table 1. These conditions are suggested by NASA for "prototype" testing of designs intended to be launched using a Nike/Black Brant motors. The components that will be tested are the mirror ring, mirror blank, mirror mounting assembly and the telescope retaining scheme at the rocket skin.

TEST SET-UP:

The mirror/ring assembly will be mounted, by means of an adapter, to the shake table (see figure 2). The adapter will be provided by SAO. It will be bolted to the 16 inch bolt circle on the shake table using bolts torqued to a minimum of 18 ft-lb. The mirror assembly will be mounted to the adapter. The mirror mounting bolts will be torqued to between 14 -16 ft-lbs. Two control accelerometers will be mounted to the adapter, six accelerometers will be mounted to the mirror and two to the ring. Their mounting locations are shown in figure 3. The Z-Z or thrust and one cross axis (y-y) will be tested in this way.

REQUIRED EQUIPMENT:

This test will require:

1) Torque wrench,

2) Nine accelerometers with signal conditioning electronics and recording devices for each channel,

3) An adapter plate supplied by SAO.

TEST SEQUENCE:

1) 1/2 g maximum resonance survey in Z-Z direction,

2) 1/2 g maximum resonance survey in Y-Y direction,

3) Sine sweep Y-Y, full,

4) Random Y-Y, intermediate level,

5) Random Y-Y, full,

6-8) Repeat 3-5 in Z-Z axis.

EXAMINATION, DURING TEST:

The assembly will be thoroughly examined between tests to determine if the mounting bolts have loosened, the optics shifted or any apparent damage occurred. Any unusual changes will be noted before proceeding. The accelerometer data will be examined to make determination if any further testing is warranted.

EXAMINATION, POST TEST:

Visual examination of all the components for signs of deterioration due to the vibration loads. The ring and blank will then be wrapped to protect the surfaces and boxed for transport back.

TEST REPORT:

The test report should include:

1) The output of the accelerometers from both the sine sweep and the random vibration tests. This should be recorded on disk for post test analysis and their amplitudes should be graphed versus frequency.

2) Graphs of the frequency content of the random vibration tests;

3) Present engineering judgement of the success or failure of the design, any recommendations and calculations.

Table 1
NASA Black Brant Shape Spec.

Sine Sweep	Rate	2 Oct/Min
Both axes		
± 5.76 in/sec		5-24 Hz
Ramp to ± 2.3 g		25-30 Hz
± 2.3 g		31-110 Hz
Ramp to ± 5.3 g		111-125 Hz
± 5.3 g		126-800 Hz
Ramp to ± 15.0 g		801-850 Hz
± 15.0 g		850-2000 Hz

Random	Duration	20 sec/axis
Both axes		
19.1 g - rms -------------------------		Overall
.023-.225 g^2/Hz		
@ 1.8 db/Oct	___	20-1000 Hz
.225 g^2/Hz		1000-2000 Hz

FIGURE: 1 NASA SHAKE SPEC SINE G-AMPLITUDE vs. FREQUENCY
REFERENCE:

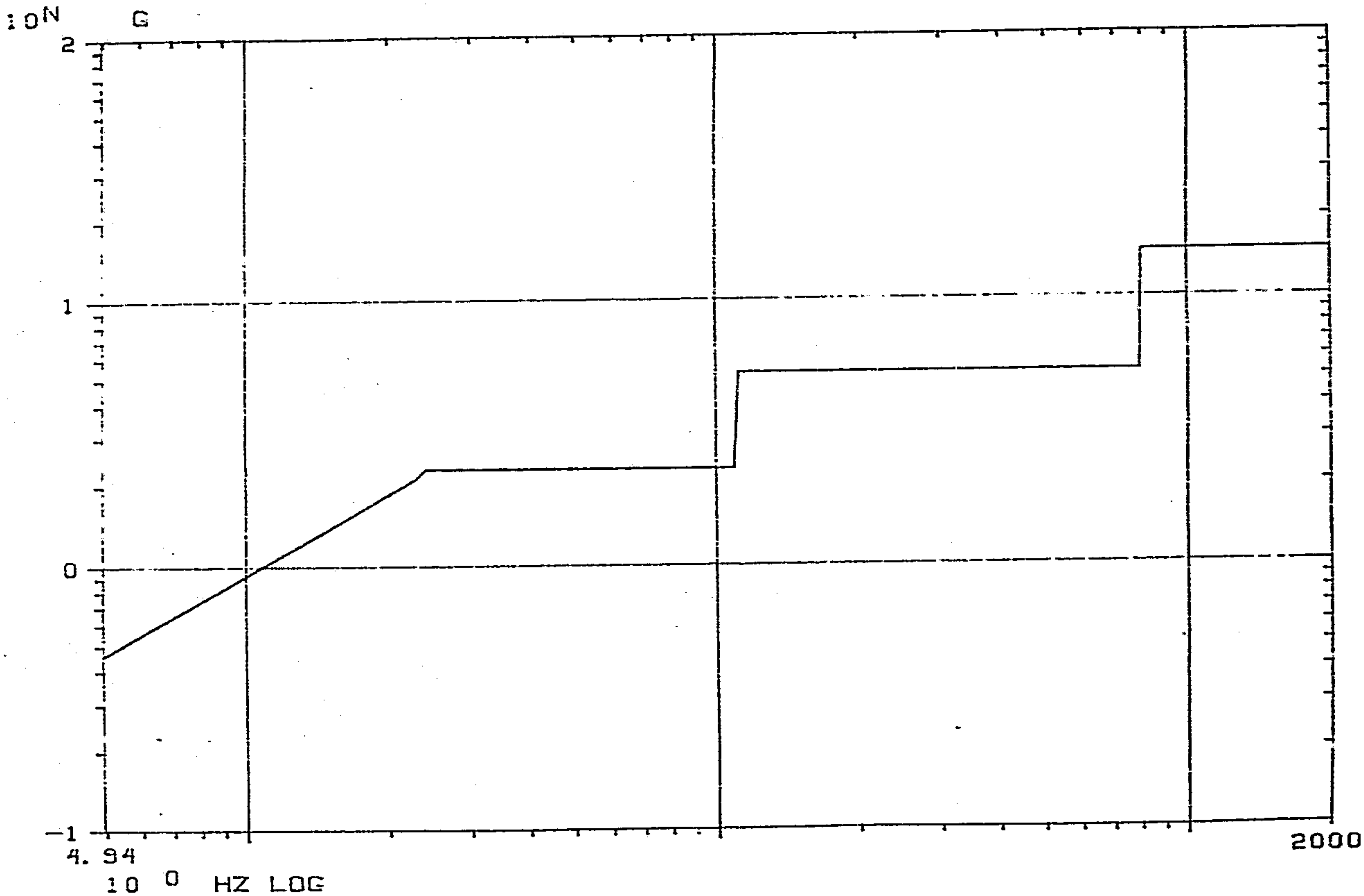


Figure. Mirror Mount Figure Distortion Test

Top Row: Mirror under no load, showing RMS figure quality of $\lambda/40$ (at 5000 Å)

Middle Row: Optics under 347-pound load, showing negligible figure distortion over the full 10-inch aperture and no spreading of the deformation away from the clamp.

Bottom Row: Mirror under 785-pound load, equivalent to 60g clamping. Figure quality is still $\lambda/40$ as in the no-load case.

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